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FEDERAL EMERGENCY MANAGEMENT AGENCY

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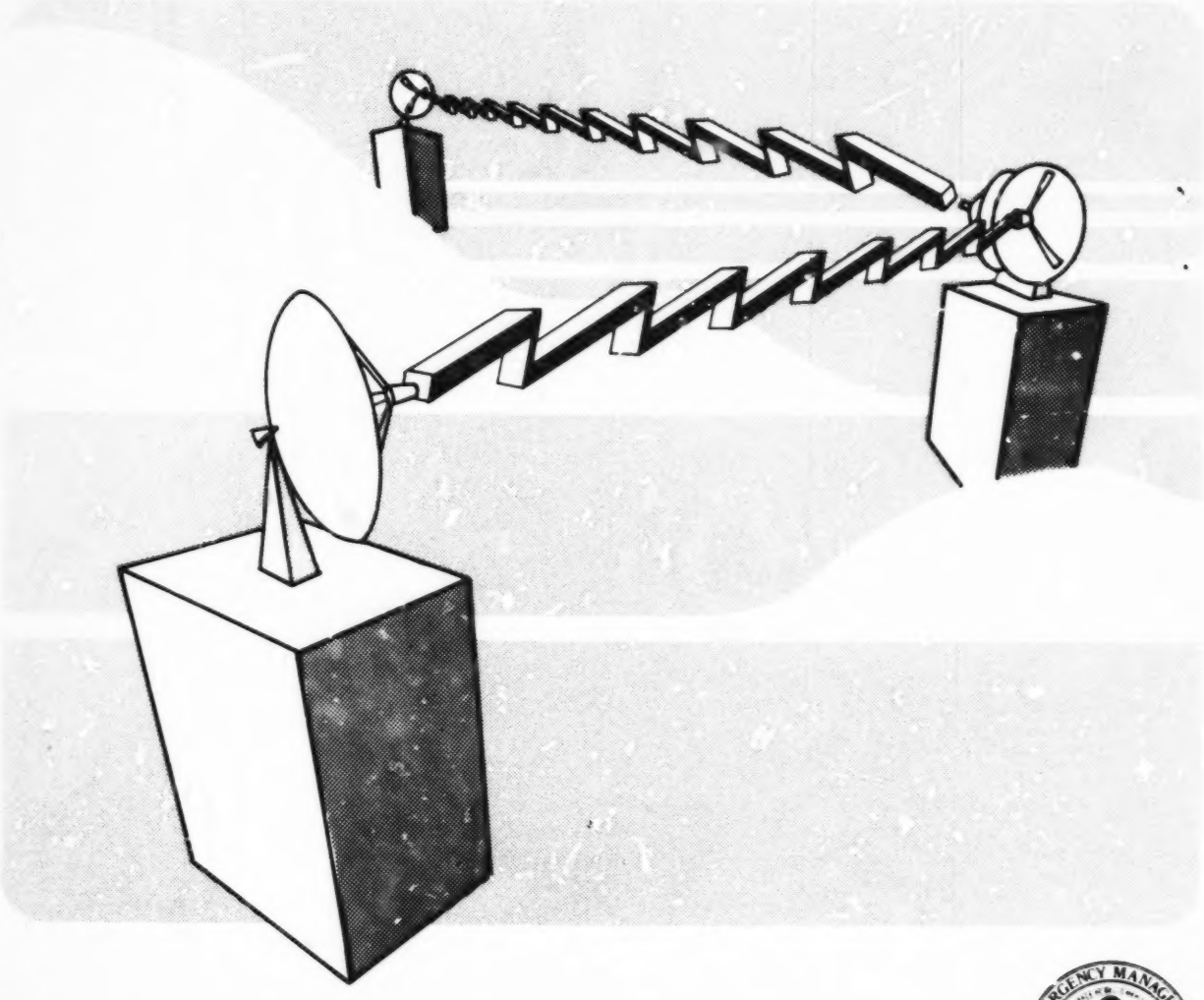
Maintenance Manual
Microwave Repeaters



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CPG 2-13J

MAINTENANCE MANUAL

MICROWAVE REPEATERS

Federal Emergency
Management Agency

Maintenance Manual
Microwave Repeaters

Introduction

The purpose of this manual is to guide you on how to maintain equipment in a microwave repeater station. The information in this manual is only a **supplement** to the recommended maintenance information supplied in service manuals provided by the manufacturers of the equipment . **Always follow the maintenance procedures provided in the manufacturer's manuals.** This manual will help you understand why maintenance is necessary. This manual will also be helpful if the manufacturer's maintenance manuals are not immediately available.

Microwaves and Their Uses

Electromagnetic waves are the way in which radiant energy, such as heat and light, is carried through space. One special variety of these waves is called microwaves. Microwaves are very short and have high frequencies, from about 3 to 300 GHz.

Microwaves are widely used in communications, especially for the telephone industry. A microweve signal is very directable and a large amount of information can be compressed into one frequency. These advantages are dampened by microwaves' inability to bounce off objects like radio waves and the expense for special equipment to send and receive microwaves.

The inability to bounce off the atmosphere (and travel great distances) is overcome by the use of stations to pass microwave signals over great distances. Using microwaves for communications requires a series of relay stations every 20 or 30 miles to pick up the signal and then to remove any noise picked up in the course of travel between stations. These stations then amplify and retransmit the signal to the next relay station. Some satellites act as microwave towers, relaying telephone, television, and other signals around the globe.

It must seem that this system of towers, antennas, transmitters, and receivers must be a very costly way of sending information. These costs are recouped by the huge information-carrying capacity of microwaves. A network of more than 4,000 microwave relay stations links cities in the United States. These stations handle thousands of phone calls each day as well as hundreds of television programs.

Description of Microwave Repeater Stations

Microwave repeater stations contain a microwave repeater and an antenna system to receive and rebroadcast the signal.

Microwave repeater

A repeater is an electronic device to simultaneously capture and rebroadcast a signal. It consists basically of a microwave transmitter and receiver. The transmitter and receiver are coordinated by a signal, indicating that a signal has been received. This signal from the receiver turns the transmitter on and off. This electronic coordinator is known as a Carrier Operated Relay (COR).

Antenna system

The main purpose of the microwave antenna is to capture the incoming signal, and then to shape the transmission so that it is aimed accurately to the next station. Microwave antennas bear little resemblance to antennas used for ordinary radio transmissions. The antennas are highly directional which helps overcome some of the technical limitations with microwave receivers and transmitters. The signal must be free from any interference from surrounding objects. For instance, local topography has to be considered; hills have to be cleared by at least 50 ft.

The antennas appear in several forms. The most common shapes are the horn and parabolic antennas. The horn antenna directs the microwave signal much like a megaphone directs a singer's voice. The flaring walls of the horn antenna acts as a large guide for the microwave signal. Parabolic antennas are dish-shaped. They are used as reflectors, focusing the microwaves in one direction.

There are other special components that make up a microwave repeater station. Amplification of the signal is generally accomplished by the antenna system head amplifer. It is usually positioned close to the center of the dish or at the base of the antenna's mast. Ordinary wire is not used to transmit microwaves from one point to another within the station. Coaxial cable and waveguides are used to transmit the signals once they are received. Coaxial cable consists of an inner wire and a layer of insulation surrounded by an outer conductor. The microwave actually travels along the insulating space between the two conductors. Waveguides are carefully machined rectangular or circular pipes through which the microwave signal travels. Propagation of the signal is achieved by alternating the electric and magnetic fields of the wave. Altogether, these components help move the signal within the station once it is received, and speed its eventual rebroadcast.

Preventive Maintenance

To ensure that the local microwave repeater stations work in an emergency, you should coordinate maintenance activities with the communication agency ultimately responsible for the station. Develop a program where you **regularly check the station to spot small troubles before they become big problems.** A program of coordinated semiannual and annual maintenance checks prevent serious problems from suddenly happening.

Routinely inspect the antenna tower. Check for frayed connections and loose bolts and parts. These checks are not normally mentioned in manufacturer's manuals, but can lead to more serious problems.

Equipment and Spare Parts

Special instruments capable of measuring very high frequencies are necessary. Ordinary mechanical and electrical tools are also needed. **You will also need instruments that are capable of measuring low amounts of power.** The cost of this equipment can be high; coordinate your efforts with your local communications company.

Maintain a list of spare parts and coordinate it with your local communications company. Solid-state equipment such as the transmitters and receivers have few user serviceable parts. The following table gives you an example of spare parts for a typical microwave transmitter and receiver.

Spare Parts: Microwave Repeater Station

Names of parts	Quantity
oscillator	1
hardline	50 ft.
wave guide	50 ft.

(Note: hardline is a special type of coaxial cable, with a solid outer shield)

Safety

Microwaves are dangerous. Microwaves are intense forms of energy and inflict burns to the skin and other damage, especially to the eyes. Only a qualified electronics technician should attempt to repair any serious electrical problems. **Follow safety precautions outlined by the agency responsible for the station and in maintenance manuals provided by the manufacturer. Exposure should be limited to no more than 10 milliwatts per square centimeter ($10mW/cm^2$).**

Maintenance Checks: As Required

1) Perform all required preventive maintenance as scheduled for microwave transmitter and receivers.

6-Month Maintenance Checks

1) Check microwave repeater enclosure for proper air temperature and moisture content.

2) Look for water leaks in the repeater station. Make sure it is watertight.

3) Check insulation of high voltage currents.

4) Inspect grounding system, including the grounding of the tower.

12-Month Maintenance Checks

1) Check antenna tower for poor connections. Poor connections introduce noise into the system.

2) Inspect antenna system for broken or missing parts and dirt. Replace and clean as necessary.

3) Inspect low noise amplifier in the center of the microwave antenna.

4) Measure voltage standing wave ratio (VSWR) of transmission line, using a rf through-line watt meter. Check maintenance guidelines to see if it is within specifications.

5) Examine transmission towers for missing and loose bolts and parts. Look for rusted surfaces. Replace, retighten, or repaint as necessary.

6) Clean and adjust the tightness of the tower's guy wires as necessary.

Corrective Maintenance: Troubleshooting

Some equipment malfunctions may be discovered during inspection of the local microwave repeater station. Contact the agency responsible for the station. You may also want to perform the tests on the following table to locate, and possibly correct, the problem.

PLEASE NOTE: This manual does not attempt to list all possible malfunctions that could occur nor can we suggest all possible remedies. Consult with the local communications company responsible for the operation of the station or manufacturer's manuals, if available, if a malfunction is not listed or it is not corrected by a prescribed procedure.

Corrective Maintenance: Microwave Repeaters

Malfunction	Possible Cause	Recommendation
1. Repeater does not rebroadcast signal	■ automatic shut down switch of station tripped	■ Reset switch. Locate and correct problem that caused switch to activate.
	■ blown fuse	■ Replace fuse. Locate and correct problem that caused fuse to blow.
		■ antenna mis-aligned
2. Excessive white noise generated	■ high voltage standing wave resistance (VSWR)	■ find and locate source of high VSWR
	■ unwanted energy reaching repeater receiver	■ clean shielding of transmitter power supply
		■ line noise or energy from some adjacent channel service. Locate and correct.
		■ burned out IF (Intermediate Frequency) filter

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